

BRAIN FUNCTION AND MALNUTRITION: NEUROPSYCHOLOGICAL METHODS OF ASSESSMENT

Edited by
James W. Prescott,
Merrill S. Read,
David B. Coursin

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AUTHORS

Allen Adinolfi, Ph.D.
Harvard University
Cambridge, Massachusetts

Tsuneo Arakawa, M.D.
Tohoku University
Tokyo, Japan

Paul Bach-y-Rita, M.D.
Smith-Kettlewell Institute of
Visual Sciences and The
University of the Pacific
San Francisco, California

Edward C. Beck, Ph.D.
Veterans Administration Hospital and
University of Utah
Salt Lake City, Utah

A. J. Berman, M.D.
The Jewish Hospital and
Medical Center of Brooklyn
Brooklyn, New York

Doreen Berman, Ph.D.
Queens College and
City University of New York
Brooklyn, New York

Neil R. Burch, M.D.
Texas Research Institute of
Mental Sciences
Houston, Texas

Enoch Callaway, III, M.D.
The Langley Porter Neuropsychiatric
Institute
San Francisco, California

H. Peter Chase, M.D.
University of Colorado
Medical Center
Denver, Colorado

David B. Coursin, M.D.
St. Joseph Hospital
Lancaster, Pennsylvania

Joaquin Cravioto, M.D.
Hospital Infantil de Mexico, IMAN
Mexico City, Mexico

Delbert Dayton, M.D.
National Institute of Child Health
and Human Development
Bethesda, Maryland

Elsa R. DeLicardie, Ph.D.
Hospital Infantil de Mexico, IMAN
Mexico City, Mexico

Philip Dodge, M.D.
Washington University
School of Medicine
St. Louis, Missouri

Ronald G. Dossett
Texas Research Institute
of Mental Sciences
Houston, Texas

Robert E. Dustman, Ph.D.
Veterans Administration Hospital and
University of Utah
Salt Lake City, Utah

Rita B. Eisenberg, Ph.D.
St. Joseph Hospital
Lancaster, Pennsylvania

Robert J. Ellingson, Ph.D., M.D.
Nebraska Psychiatric Institute
Omaha, Nebraska

Gary C. Galbraith, Ph.D.
Pacific State Hospital
Los Angeles, California

Robert G. Heath, D.Sc., M.D.
Tulane University
School of Medicine
New Orleans, Louisiana

Williamina A. Himwich, M.D.
Galesburg State Research Hospital
Galesburg, Illinois

Daniel W. Hubbard, V.M.D., Dr.P.H.
University of Tennessee
Knoxville, Tennessee

David J. Kallen, Ph.D.
Michigan State University
East Lansing, Michigan

Robert E. Klein, Ph.D.
Instituto de Nutricion de
Centro America y Panama
Guatemala, Central America

Leonard S. Lustick, M.M.E.
Tulane University
School of Medicine
New Orleans, Louisiana

R. Bruce Masterton, Ph.D.
Florida State University
Tallahassee, Florida

David R. Metcalf, M.D.
University of Colorado
School of Medicine
Denver, Colorado

Fernando B. Monckeberg, M.D.
Universidad de Chile
Santiago, Chile

Patrick M. Morgan, D.V.M., Dr.P.H.
Oklahoma State Department of Health
Oklahoma City, Oklahoma

A. C. Mundy-Castle, Ph.D.
University of Lagos
Lagos, Nigeria

G. Pampiglione, M.D.
The Hospital for Sick Children
London, England

Arthur H. Parmelee, M.D.
University of California
Los Angeles, California

Sheila Pereira, M.D.
Christian Vellore College and
Hospital
Vellore, Tamil Nadu, India

James W. Prescott, Ph.D.
National Institute of Child Health
and Human Development
Bethesda, Maryland

Gordon Pryor, Ph.D.
Stanford Research Institute
Menlo Park, California

Merrill S. Read, Ph.D.
National Institute of Child Health
and Human Development
Bethesda, Maryland

John M. Rhodes, Ph.D.
University of New Mexico
Albuquerque, New Mexico

Daniel N. Robinson, Ph.D.
Georgetown University
Washington, D.C.

Pedro Rosso, M.D.
Columbia University
New York, New York

Bernard Saltzberg, Ph.D.
Tulane University
School of Medicine
New Orleans, Louisiana

Anthony A. Sances, Jr., Ph.D.
The Medical College of Wisconsin
Milwaukee, Wisconsin

Russell D. Snyder, Jr., M.D.
University of New Mexico
School of Medicine
Albuquerque, New Mexico

John A. Stern, Ph.D.
Washington University
St. Louis, Missouri

Walter Surwillo, Ph.D.
University of Louisville
School of Medicine
Louisville, Kentucky

Walter Unglaub, M.D.*
Tulane University
New Orleans, Louisiana

Myron Winick, M.D.
Columbia University
New York, New York

*Deceased

FOREWORD

The National Institute of Child Health and Human Development was established to further understanding of the multiple factors that shape the development of each individual. These factors range from the biochemical mechanisms underlying cell growth and function to the social environment in which the individual lives. Through the Institute's history special attention has been devoted to the interplay between the biological and behavioral components of development. It is in this context that the central nervous system assumes unique importance.

We were pleased to be able to join the U.S.-Japan Cooperative Medical Science Program in sponsoring the conference on which this book was based. The timeliness of the subject and the potential of the methods discussed are even greater than at the time of the original meeting. In fact, nearly all of the papers have been expanded with recent findings and several others have been specially written to broaden the scope of this volume.

We hope that the pediatricians, psychologists, neurologists, nutrition scientists, and others concerned with human development will find this monograph stimulating and helpful.

*Gerald D. LaVeck, M.D., Director
National Institute of Child Health
and Human Development*

Bethesda, Maryland August 1974

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PART I

INTRODUCTION

INTRODUCTION

James W. Prescott

Merrill S. Read

*National Institute of Child Health and
Human Development,
Bethesda, Maryland*

David B. Coursin

*Research Institute, St. Joseph's Hospital,
Lancaster, Pennsylvania*

During the past 20 years, there has been an increasing awareness of the possible adverse effects of malnutrition on the growth, development and function of the central nervous system in man. The questions of cause, extent, significance, consequences, and preventive measures have become of worldwide concern to the general public, to national leaders, and to scientists in many different disciplines. In the United States, congressional hearings have recognized the issue of malnutrition as a major problem of social conscience and have established a national priority for scientific inquiry into the effects of malnutrition upon human development.

The challenge of assessing the impact of malnutrition upon the developing brain and behavior, particularly in the social context of human communities, has proven to be a much more formidable task than was originally anticipated. It has become increasingly clear that a single scientific discipline cannot determine all the causative factors nor the consequences of malnutrition upon human development. Malnutrition is only one of many interacting variables that contribute to child development in an impoverished population. For example, infectious diseases limit a child's capability to utilize available nutrients. Social structures in the family and traditional living patterns often determine the distribution of available nutrients within the family—the young child frequently being the loser in the family hierarchy where, among other factors, it is not recognized that a young child needs more nutrients than an adult. Similarly, patterns of social interaction within the family determine to a large extent the intellectual-cognitive stimulation given the young infant and child. In situations where the mother is absent due to employment, illness, or rejection, or where the young child experiences recurrent illness, the resultant maternal-social deprivation may have consequences for the developing sensory systems and brain structures which, in turn, affect and limit patterns of behavior. These are but a few examples of the complexities encountered in assessing the impact of malnutrition upon human development.

Research on nutrition and behavior has tended to focus primarily on the biochemical, medical, anthropological, sociological, or psychological facets of the problem, with primary emphasis on clinical methodology. On the other hand, neurophysiology, with its increasingly intricate electronic systems and baffling mathematical constructs, has remained apart from nutrition studies. Nevertheless, electrophysiological and neuro-

psychological techniques offer an opportunity to bridge the gap between the biomedical and the behavioral facets of the problem. Neuropsychological techniques could provide valuable clues as to how nutritional factors influence neurochemistry, which in turn affects neurophysiology and alters psychological performance.

One of the earliest attempts to relate a simple vitamin deficiency directly to brain activity involved vitamin B₆ (Ref. 1); Coursin and his colleagues used the electroencephalogram to monitor maturation of the central nervous system in normal and abnormal infants. Introduction of auditory-evoked responses improved the methodology. Ultimately, it was found that certain infants with hyperirritability, hyperacusis, behavioral abnormalities, and generalized convulsive seizures accompanied by changes in the EEG had been raised on a formula marginally deficient in vitamin B₆. The derangement in central nervous system function, with its accompanying behavioral and neuroelectrical symptoms, was corrected within an incredibly short period of time by administering adequate vitamin B₆. These observations have been confirmed and extended by others to numerous B₆-related metabolic pathways, to a variety of B₆-antimetabolites, to biotin, and to certain aspects of protein insufficiency.

Until recently, progress has been hampered by dependency upon visual inspection of tracings. In the past 10 to 15 years, however, new methods have been developed that permit rapid computer analysis of wave forms, cutting through the ever-present "noise" in the tracing. Simultaneously, tracing, storing, and transport systems have improved, along with highly sophisticated theoretical constructs leading to new approaches to analysis and equipment refinement. Several investigators have brought these new methods to bear on clinical problems; their findings are summarized elsewhere in this volume. Only a few efforts have applied the newer techniques to studies of malnutrition, although such an application would appear to be potentially highly illuminating.

The papers in this book were derived from a conference entitled "Neuropsychological Methods for the Assessment of Impaired Brain Function in the Malnourished Child" co-sponsored by the U.S.-Japan Cooperative Medical Science Program and the National Institute of Child Health and Human Development (NICHD). The former is concerned with problems encountered by the people of Southeast Asia, with a major emphasis on nutrition. The NICHD sponsors research on all facets of human development, with particular concern for the interplay between the biological and the behavioral. Both organizations are particularly interested in nutrition as one factor that influences mental development.

It was the intent of the 5-day conference to bring together scientists of diverse scientific disciplines to explore potential contributions from each discipline toward assessing the effects of malnutrition, to illustrate the state of the art and current limitations in the pursuit of these objectives, and to provide a forum for dialogue which, hopefully, would lead to more effective research programs in delineating and identifying the effects of malnutrition upon mental development. Specialists in nutrition, public health, infectious diseases, biochemistry, neurology, pediatrics, neuropsychiatry, electroencephalography, neuropsychology, biomathematics, information processing, psychophysics, developmental psychology, and sociology participated in the lively and provocative dialogue. Many of the papers presented in this book represent an updating of those presented at the conference; others have been specially written to round out the volume and enhance its value to others interested in nutrition, electrophysiology, behavior, and central nervous function.

During the course of the conference, a number of demonstrations were presented

involving computer analyses of EEG data stored on magnetic tape, as well as on-line computer analyses from both human and monkey subjects. These demonstrations enhanced the discussions and broadened understanding of several of the papers or methods presented. The authors are deeply indebted to the following four companies for their contributions of equipment and personnel both before and during the meeting: Beckman Instrument Company, for the biomedical instrumentation for stimulation and recording of the EEG; Time-Data, Inc. and Fabri-Teck, Inc., for the computers for demonstrating the variety of analytic procedures available for processing the same data base; and Tektronix, Inc., for the large remote-display scopes to facilitate viewing of the computer outputs. These arrangements made it possible to perform live experiments, to illustrate appropriate and inappropriate methods of analyses for a given data base, and to emphasize that different kinds of information could be obtained from the same data base with different kinds of analyses.

Although this volume cannot reflect the dynamic human interactions that occurred during that week—the low points of failures in communication and the high points of successful communication—it can perhaps reflect the spirit of the discussions in furthering interdisciplinary research and understanding.

In overview, these efforts at promoting interdisciplinary communication bring to mind the classic paper of D.O. Hebb (Ref. 2) “Alice in Wonderland, or Psychology Among the Biological Sciences,” wherein he summarized the relationship between the psychological and neurological disciplines of the era of the 50’s, as follows:

For their part, psychologists too often fail to keep themselves informed about what goes on in the neurological field and, in defense of such ignorance, too often deny that it has any relevance for their work—a position so preposterous and indefensible that it is hard to attack.

It is perhaps not too presumptive to suggest that what D.O. Hebb had to say about psychology and neurology in 1958 can be said about pediatric medicine and neuropsychology today. Hopefully, the “adventures” presented in this volume contribute to a better understanding of the evolution and evaluation of developmental processes as they relate to the problems of clinical developmental medicine in achieving excellence in diagnostic and prognostic procedures.

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PART II

MALNUTRITION, GROWTH, AND DEVELOPMENT

